Overview

- What is remote sensing

- Sensors and types of remote sensing

- Manual extraction of data from imagery
  - Key characteristics of imagery interpretation
  - Categorizing by the 13 themes of Human Geography

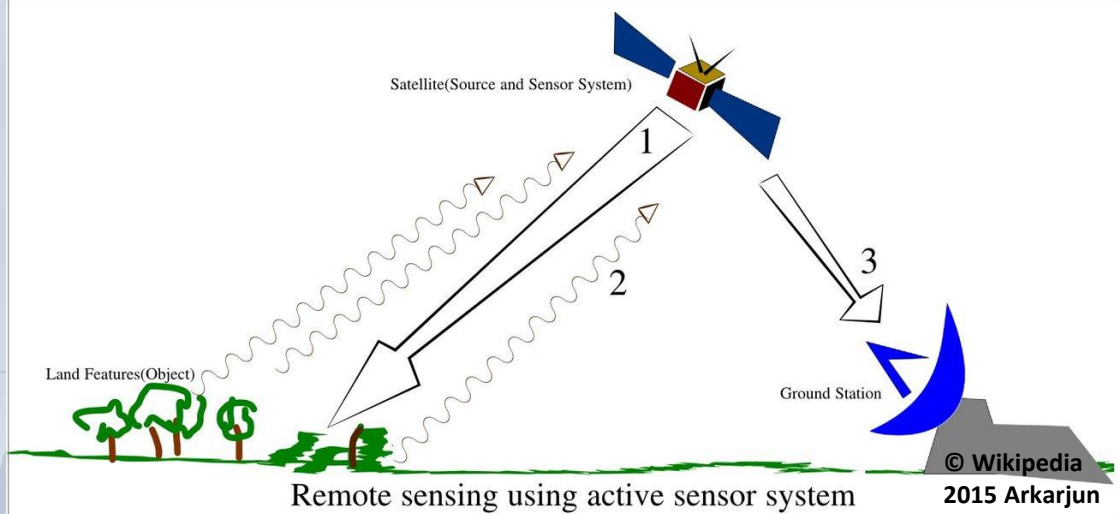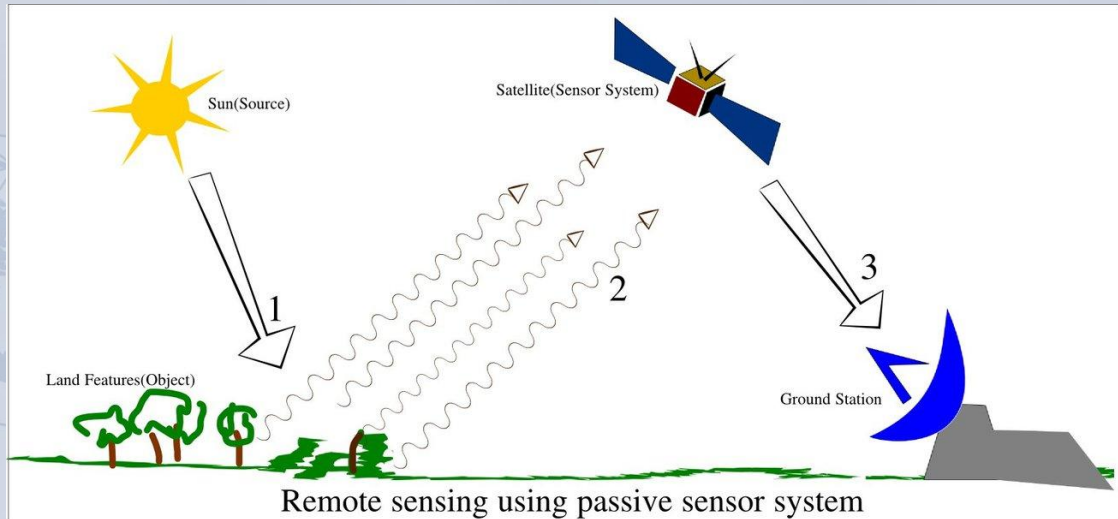- Automated extraction of data from imagery

Remote Sensing

- Process of acquiring information of an object or area without physical contact.

- Two main types: Active and Passive

- Passive: detects natural radiation that is emitted or reflected by the object or surrounding area being observed (ex. Photography, Panchromatic or Multi-spectral Imagery)

- Active: emits energy in order to scan objects and areas (ex. RADAR/LIDAR, elevation data)

Radiation and Wavelength

- Passive and Active sensors

- Data saved as bands of wavelength

Blue, 450-515..520 nm,
Green, 515..520-590..600 nm,
Red, 600..630-680..690 nm,
Near infrared, 750-900 nm,
Mid-infrared, 1550-1750 nm,
Mid-infrared, 2080-2350 nm,
Thermal infrared, 10400-12500 nm,

Remote sensing using passive sensor system

Remote sensing using active sensor system

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Characteristics of Overhead Imagery

- Resolution (Ground Sample Distance)

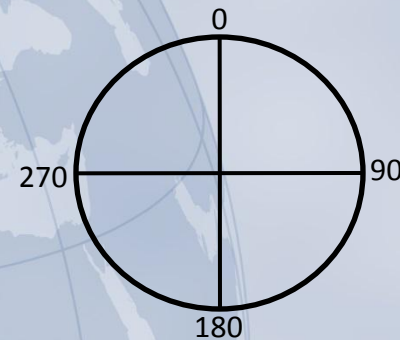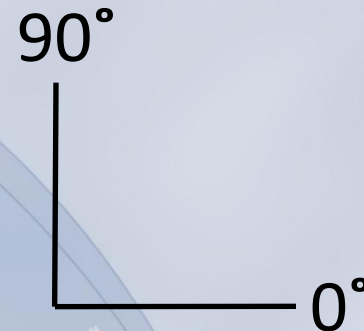 - Relates to size of image pixels

- Angle of elevation

  - Relates to angle of perspective

- Azimuth

  - Relates to direction of perspective (N, S, E, W)

90°

0°

0

270   90

180

5

Overhead Imagery

- 'Overhead imagery' is collected by two types of platforms:

Satellites

Airborne

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Imagery Satellites

- Commercial sensors (data may cost money)

  - Includes: DigitalGlobe, SPOT, RapidEye, EROS

  - High resolution

  - Panchromatic and multi-spectral

- Government and other Civil Sensors

  - Includes: LANDSAT Imagery (data free online)

  - Low resolution, multi-spectral

  - Panchromatic, Multi-spectral, Thermal

Commercial Imagery Examples

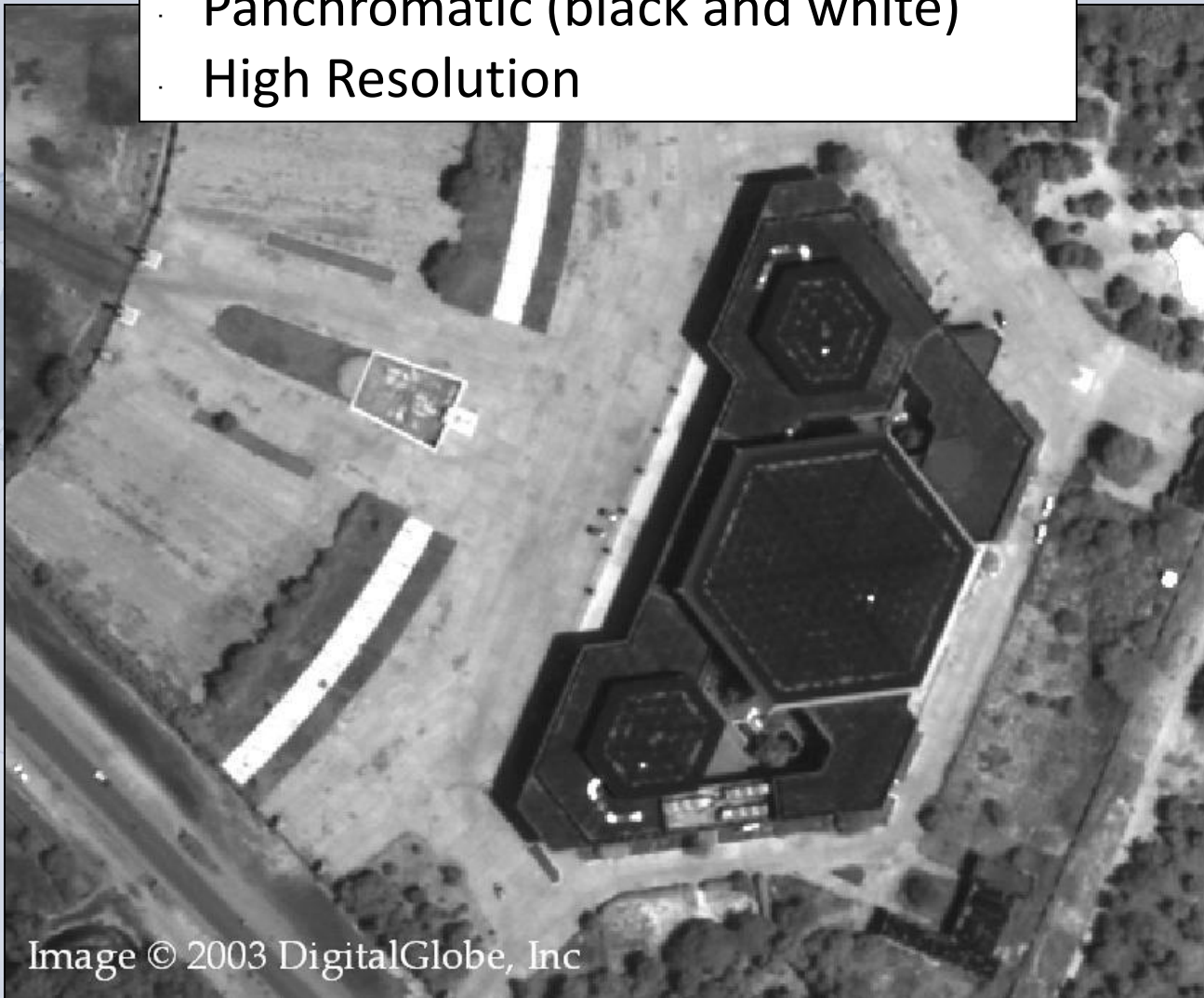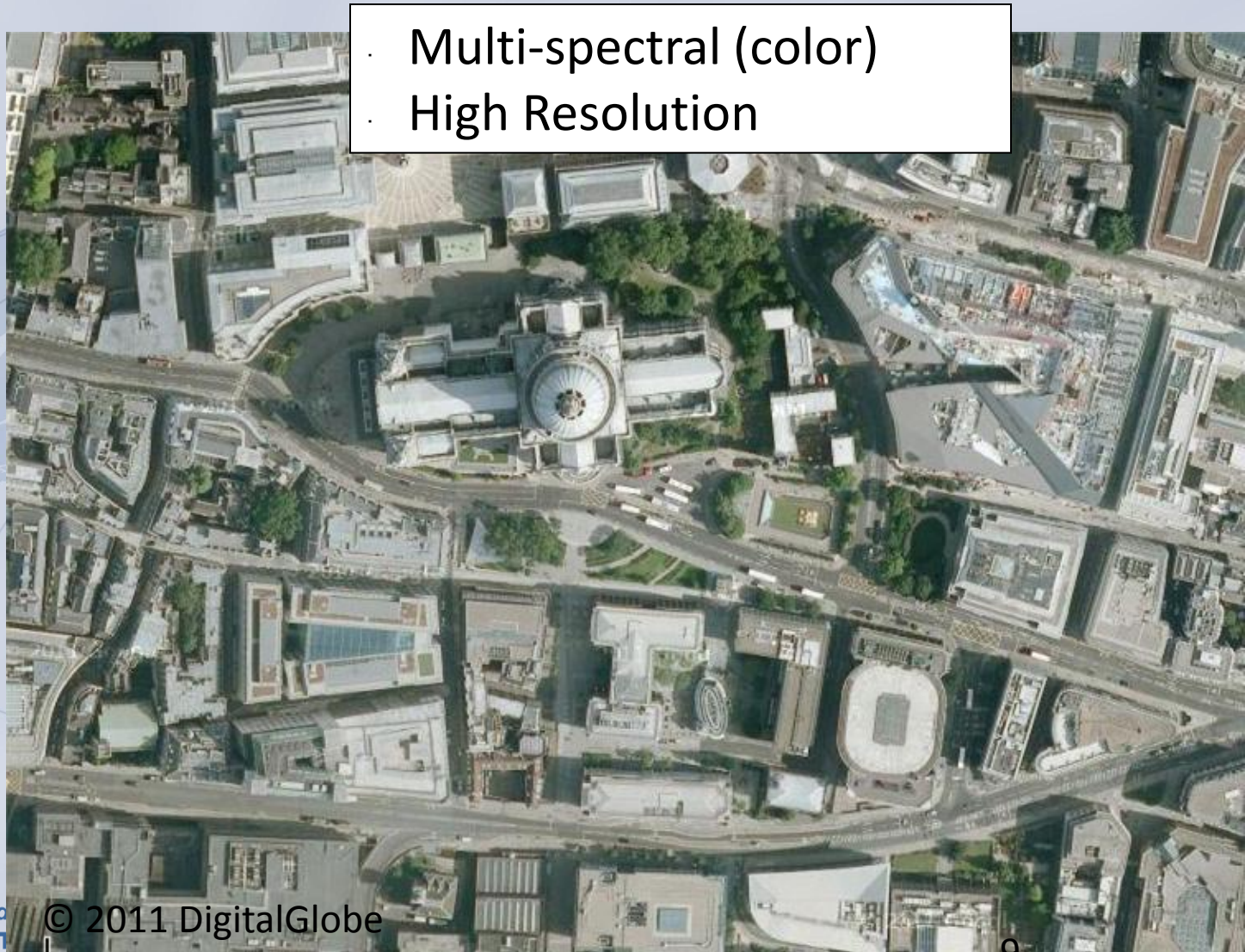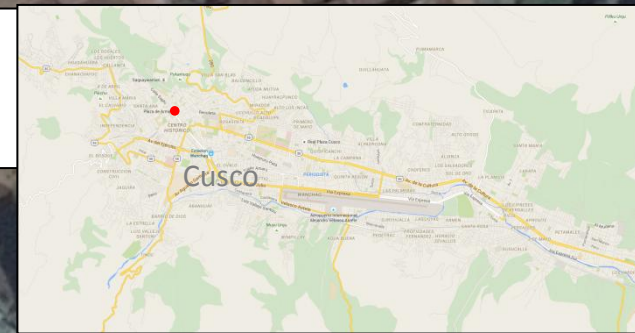- Panchromatic (black and white)
- High Resolution

Image © 2003 DigitalGlobe, Inc

Commercial Imagery Examples

- Multi-spectral (color)
- High Resolution

© 2011 DigitalGlobe

Environment/Land: Plaza of cultural significance
Plaza De Armas, Plateros, Cusco, Peru
Geo: -13.5167, -71.9787

Example Product: Imagery Graphic

N

Plaza Boundary

© 2015 Digital Globe © 2015 Microsoft Corporation

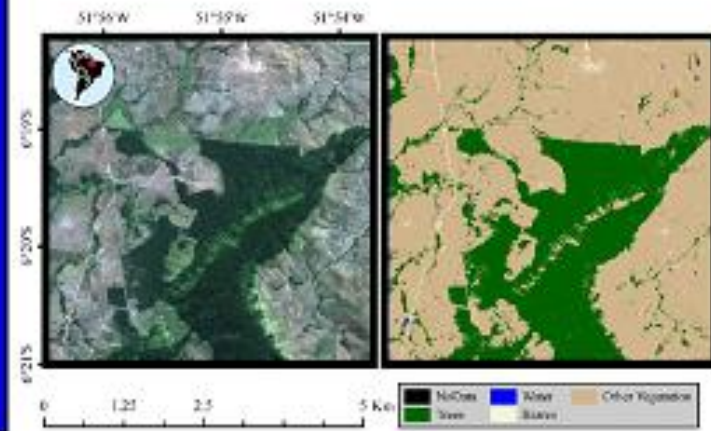# LANDSAT Imagery Example
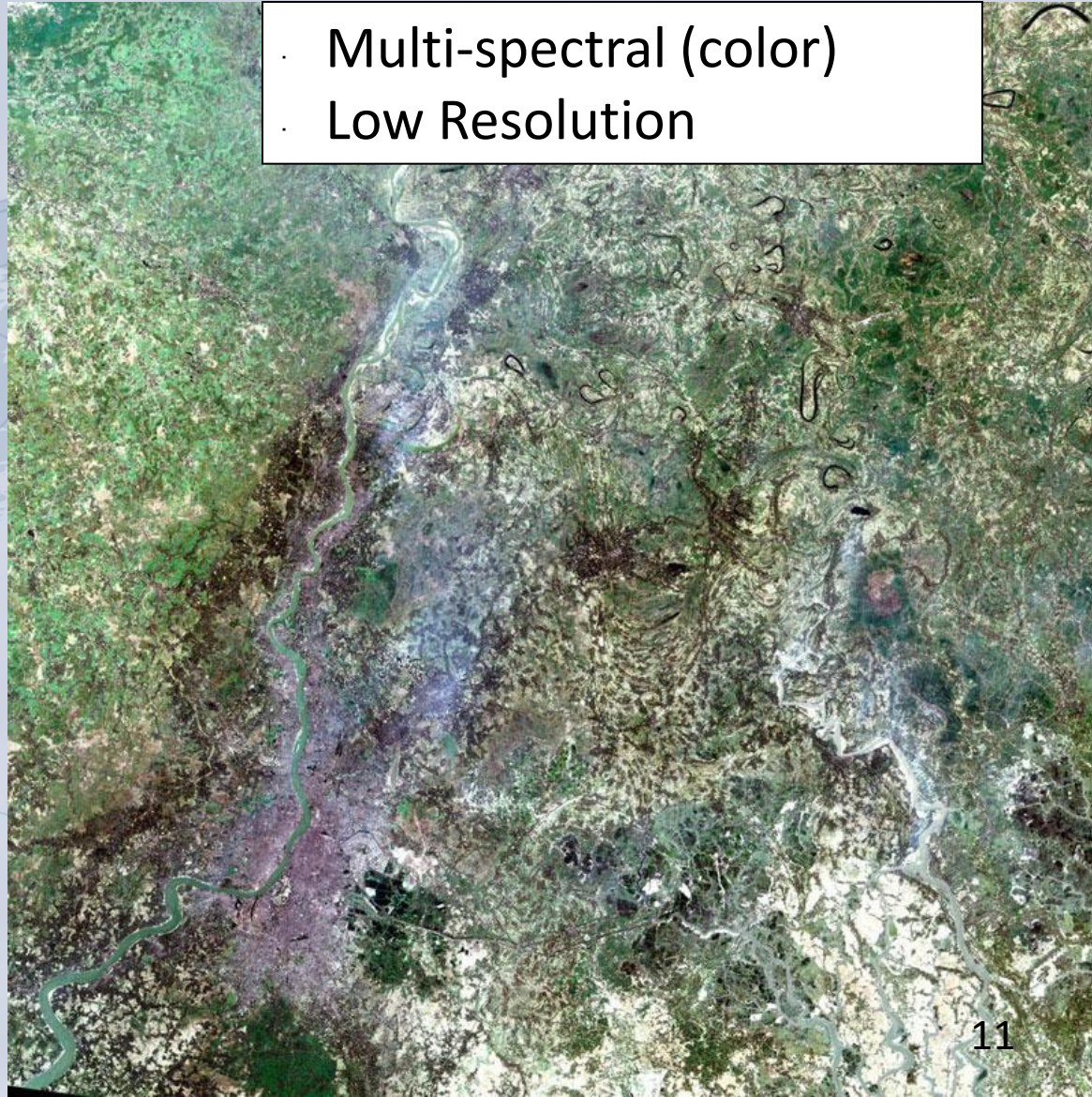
- Multi-spectral (color)
- Low Resolution

Example LANDSAT Analysis

Land cover map of 2010 (left), zoomed in area (up), validation with very high resolution data (down)

Water
Forest
Barren
Other
Snow/Ice
Urban
No Data

Giri, C.; Long, J. Land Cover Characterization and Mapping of South America for the Year 2010 sing Landsat 30 m Satellite Data. *Remote Sens.* **2014**, *6*, 9494-9510.
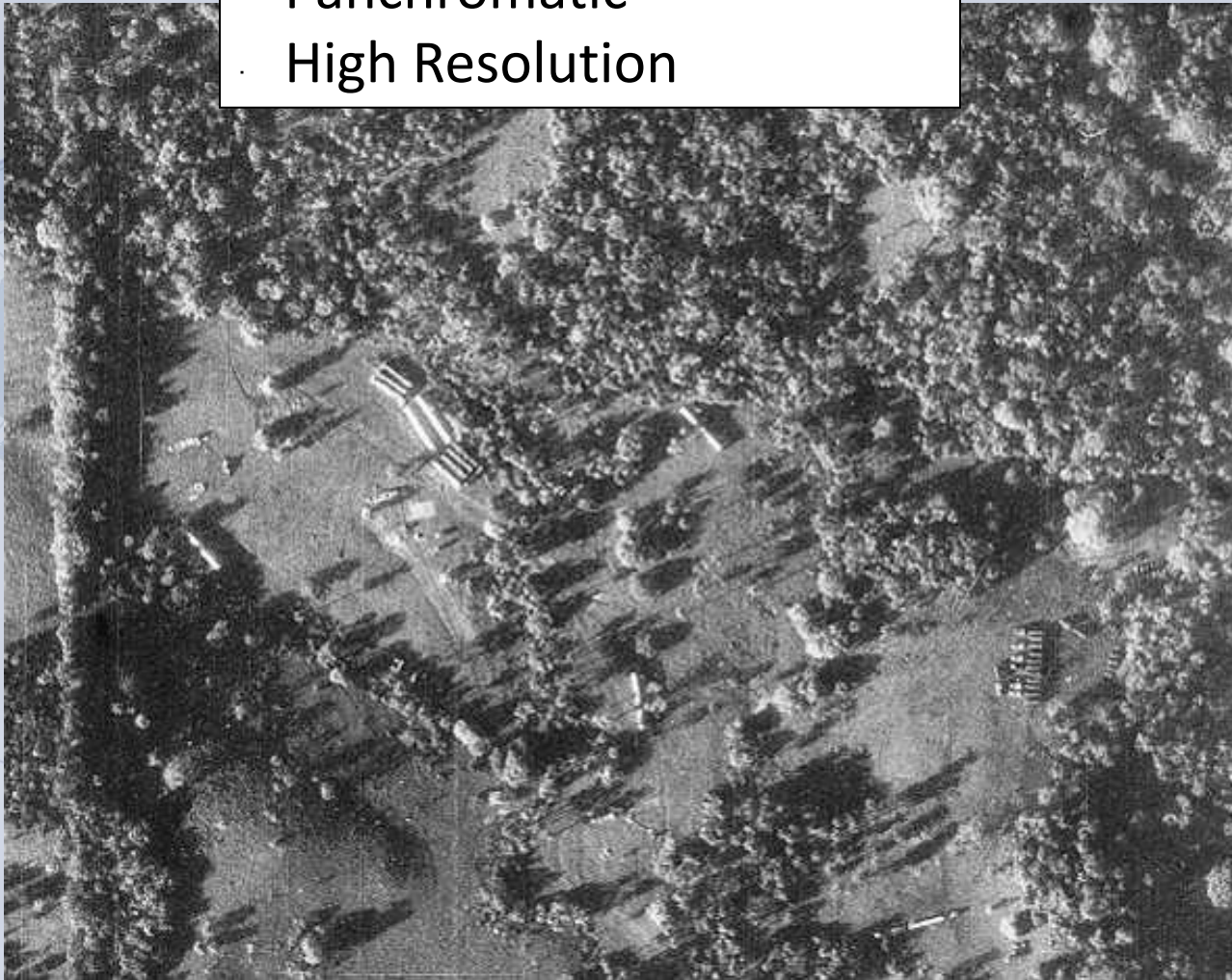
Airborne Imagery

- Variety of platforms available
  - Helicopter, Aircraft, Unmanned Aerial Vehicle ("drone")

- Can provide a higher resolution
  - Sensor dependent

- Full motion video and still image capability
  - Panchromatic and multi-spectral
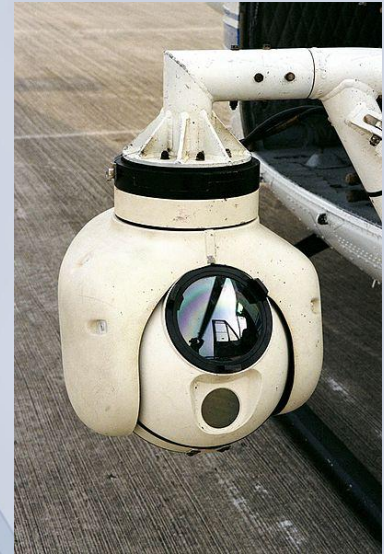
Airborne Imagery Example (Still)

- Panchromatic
- High Resolution

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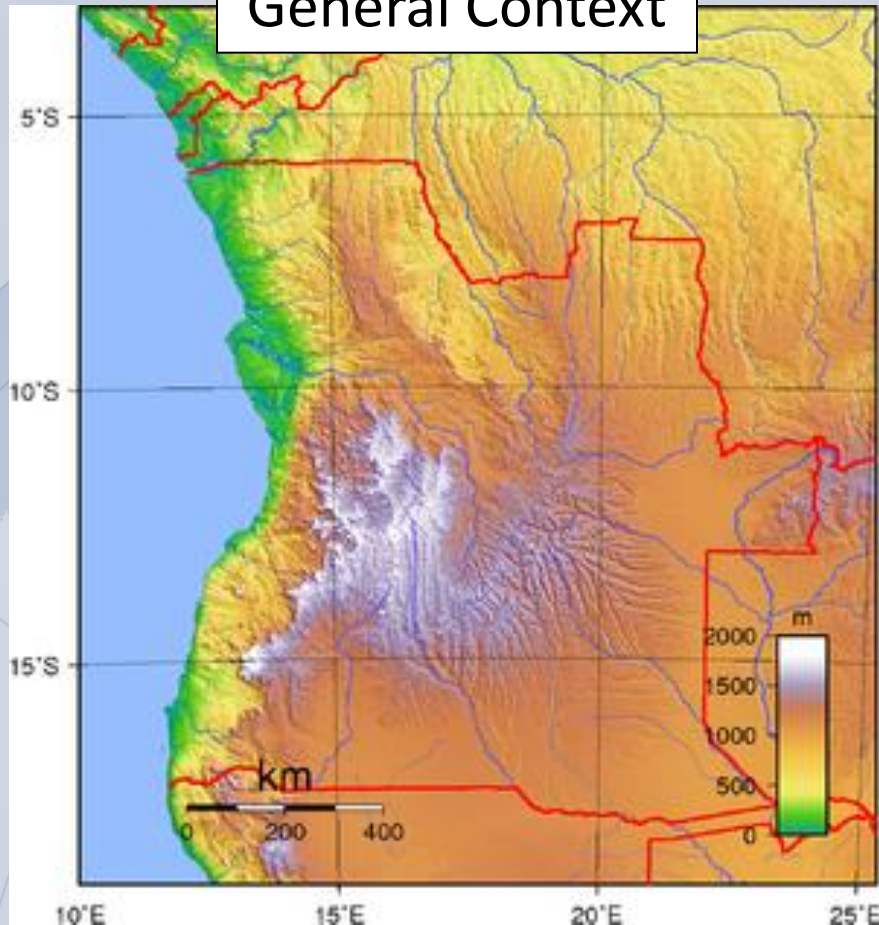OFFICE OF THE GEOGRAPHER

Elevation/Topography

- Active Sensor (Satellite and Aircraft)

  – SRTM, LIDAR

- Resolution/Accuracy

- Terrain Analysis

  – Drainage, Slope

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Topographic Products

General Context

Urban Planning

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Extracting Data from Imagery

Manual or Automatic Extraction

- Manual Extraction
  - Visual observation of the imagery and the creation of new data layers
  - Digitize (draw) points, lines or polygons from imagery
  - New data is created in the projection of your underlying image
  - Add attributes to describe the data
    - Directly from imagery observation and analysis
    - From other source material

Manual or Automatic Extraction

- Automated Extraction
  - Classification of raster data
  - New data is created in the projection of your underlying image
  - Requires some human input and verification

Manual Data Extraction: Imagery Observation and Analysis

The 8 Key Image Characteristics

- **Shape**

- **Size**

- **Shadow**

- **Scale**

- **Position**

- **Pattern**

- **Tone or Color**

- **Texture**

Image Characteristics: Shape

- The general form, configuration or outline of an object or site

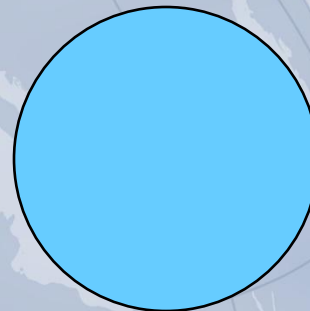- Characteristic shapes make some objects quickly and easily identifiable

Image Characteristics: Size

- The dimensions, surface, and volume of an object

- The size of an unknown object can be estimated by comparing it to the size of a known object

Analyzing Imagery: Size and Shape

- We can use the size versus the shape of object (its *proportions)* to help identify it

- For example, vehicles often have distinct proportions depending on their intended use:

4.8m x 1.8m
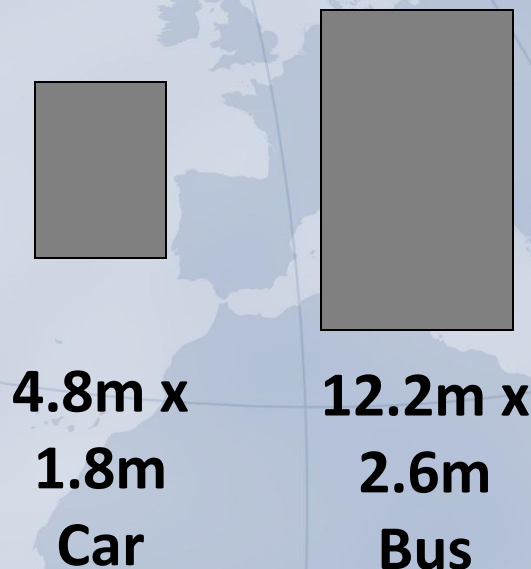
Car

12.2m x 2.6m

Bus

24

Image Characteristics: Tone

- The brilliance or shade of light reflected by an object

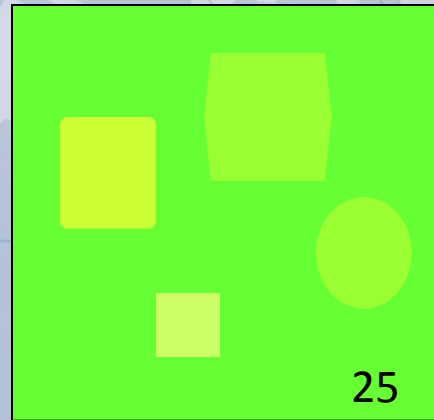- Tonal differences allows discernment between various shades of gray or color
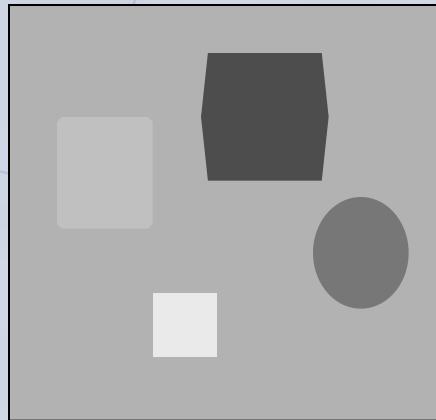
Image Characteristics: Texture

- The frequency of structure or surface change within the imagery (smooth / rough)

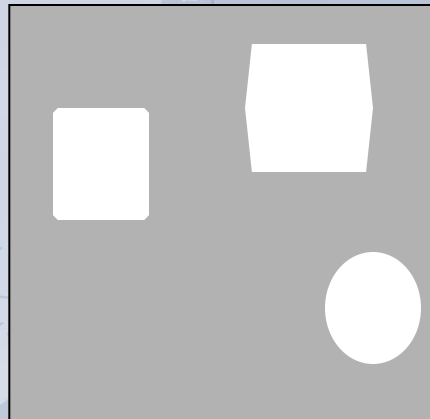- It is used in all aspects of imagery exploitation

Image Characteristics: Shadow

- The shadow of an object can provide the overall shape or profile of that object

- Shadows may reveal objects that may not be directly visible on imagery

Image Characteristics: Scale

- The ratio of the size of the image of the object to the size of the actual object

Image Frame

Object 100%
1:1
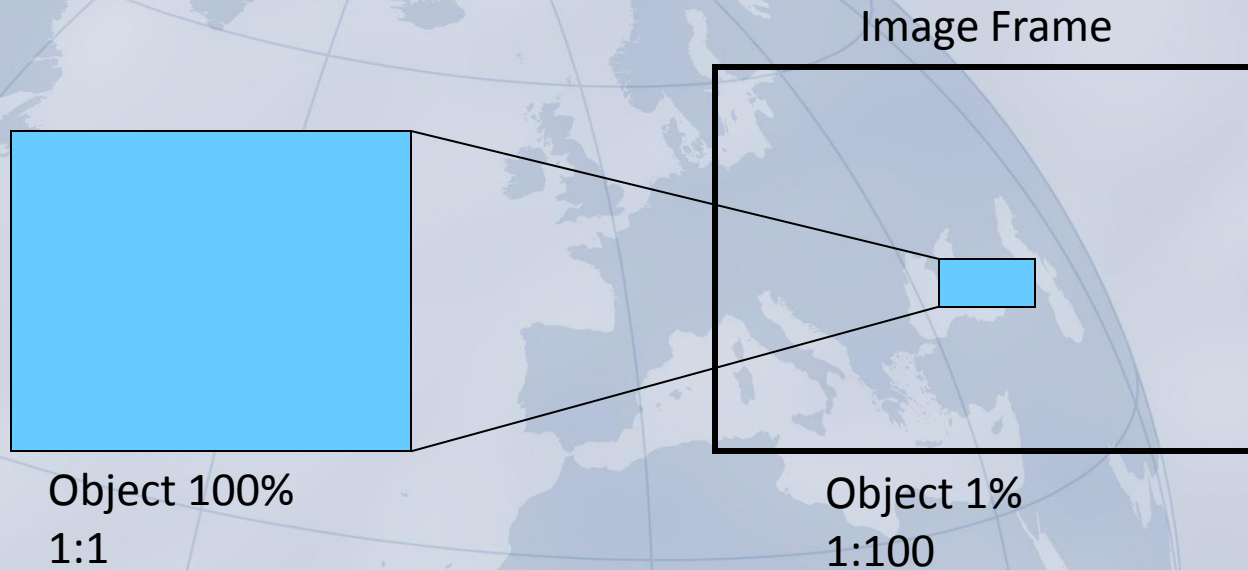
Object 1%
1:100

Image Characteristics: Position

- The location of an object in relation to its environment

    - When analyzing imagery, always look around at the adjacent areas on the imagery

    - Beware of "tunnel vision"

    - It is important to know the location you are observing!

Image Characteristics: Pattern

- The spatial arrangement of objects

- It is especially important when interpreting transportation centers or cultural sites
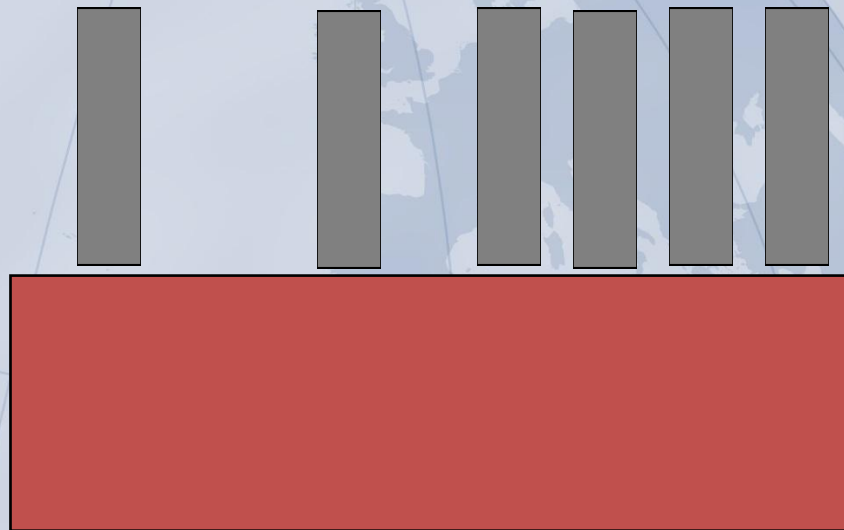
Applying imagery extraction to human activities

Identify these locations

– Large grassy rectangle, with white lines and a white arch on each end

– Many railroad tracks leading to one building

– Large open space in a city with a fountain or statue in the center

– Long strip of concrete with planes on each side

– A building in the shape of a cross

– Many buses in one parking area in a city

...through imagery interpretation

Fútbol

© 2015 Digital Globe © 2015 Microsoft Corporation

Railroad station

Plaza

Airport

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Una Iglesia

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Bus Station

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Organizing social data extracted from imagery

Spatial Data on Human Activity - Categorized by Social Theme

- Human Geography (HG): How human activity affects or is influenced by the earth's surface.

- Can be divided into 5 groups with thirteen themes:

  - Populations
  - Affiliations
  - Interactions

  - Environment
  - History

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I. HG themes for Populations

- 1) Demography
  - Population characteristics:
    - Gender
    - Age

- 2) Economy
  - Indicators of wealth and income
  - Infrastructure: Energy

- 3) Education
  - Education
  - Literacy Rates

- 4) Health and Medical
  - Health indicators
  - Medical infrastructure

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II. HG themes for Affiliations

- 5) Ethnicity
  - Population by ethnicity

- 6) Religion
  - Population by religion
  - Religious buildings

- 7) Groups and Organizations
  - Formal groups
  - Informal groups
  - Headquarters

III. HG themes for Interactions

- 8) Language
  - Distribution of language or dialects

- 9) Communications and Media Use
  - Cell towers, telephone lines
  - Television stations, newspaper offices
  - Post offices

- 10) Transportation Use
  - Roads & railroads
  - Airport locations
  - Bus routes

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IV. HG themes for Environment

- 11) Water Supply and Control
  - Surface water supplies (rivers, lakes)
  - Wells
  - Water treatment facilities
  - Distribution infrastructure
  - Access points

- 12) Land
  - Land cover
  - Land use
  - Ownership
  - Cultural significance

V. HG theme for History

- 13) Significant Events
  - Natural Disasters
  - Political Changes
  - Treaties

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Summary

- Why use imagery as a data source
    - Imagery can be a historic or recent source of data, and can show change over time
    - Through visual observation (manual) or automated processes data can be derived to identify elements of human activity
    - This human activity data can be categorized into the 13 themes of Human Geography

- Tip to remember
    - Check image projection to ensure data accuracy

Remote sensing resources:
Data & Digitizing Tools

- **Online Imagery Viewers (date of imagery and resolution can vary)**
  - Google Maps https://www.google.es/maps
  - Bing Maps https://www.bing.es/maps/ (Vista de pájaro: Aérea)
  - Wikimapia www.wikimapia.org (en Español)
  - Yahoo! Mapas https://espanol.maps.yahoo.com (Satélite)

- **USGS Landsat Imagery** http://landsat.usgs.gov/Landsat_Search_and_Download.php

- **SRTM Topographic data**
  - Description en Español: http://www2.jpl.nasa.gov/srtm/media_06_19_2003_sp.htm
  - Data download: http://www2.jpl.nasa.gov/srtm/cbanddataproducts.html

- **Open source and online GIS data creation tools (capabilities vary)**
  - Google Earth https://earth.google.es/
  - Open Street Map http://wiki.openstreetmap.org/wiki/WikiProject_Per%C3%BA
  - ArcGIS Online http://www.esri.es/es/productos/arcgis/arcgis-online/
  - QGIS http://www.qgis.org/es/site/

- ¿**Otras**?